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Banana Fibre Extraction Machine

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Abstract: The aim of this project is to design and develop a process to extract high quality natural fibers from the banana pseudo stems. Manual extraction of banana fiber produces good quality of fiber but it much time consuming. Labour expense is quite high and output is quite low. Hence efficient extraction of banana fiber can only be possible through mechanization. Now a day's machines exist for extracting banana fiber but are manually operated and cannot be applied for mass production. This project is specially designed for extracting banana fibre from the banana stem. The machine is designed in a very simple way such that it can be used by everyone, as the mechanism is very simple. In this paper, extracted banana fiber (EBF) and waste banana fiber (WBF) were characterized in terms of chemical and morphological properties to produce handmade paper. WBF was characterized with lower α–cellulose, lignin content and longer fiber length. Pulping of EBF and WBF was carried out with varying active alkali and cooking time at boiling temperature. Pulp yield of WBF was 35.9% after 120 min of cooking with 8% alkali charge.
Keywords: blade, belt and pulley, motor, and roller shaft

I. Introduction

Textile industry has various untapped resource for the production of fibres, one such resource is natural plants. Natural plant stems/stalks/leaves fibers have been in use extensively in fast decade for production of Handicraft, Ropes etc. The huge availability of a natural plant stems/stalks/leaves is very tempting to use it for garment purpose. However, the main objective of growing of these plants is production of fibre only. Banana (Musa sp.) is a well-known important fruit crops grown in all over the world and can also be used as alternative source of useful quality fibres. The fruit bunches and leaves are main source of income, besides the leaves are used as bio plates for serving food in homes and functions. Though the technologies for extraction of fibres and paper making from pseudostem are available, yet it has not been adopted by the industries mainly due to high transport cost. However, there exist a vast potential of extracting fibres from pseudostem. It is estimated that annually 17,000 tonnes of fibre can be extracted from the waste portion of the banana plant, valued at roughly Rs. 85 crore (Rs. 50,000 per tonnes). There appears to be good scope of profitable use of this fibre in textile and paper industries on commercial scale. Not only this, but number of high value products like carpets, coasters bags and different types of handicrafts can also be developed from banana pseudostem. In brief, banana fibre has a bright future and arena to perform in the forthcoming years.

A. Natural Fibres: Natural fibres are obtained from natural sources. It has many advantages over artificially manufactured synthetic fibres. These fibres have high specific properties with low density. They are eco-friendly unlike synthetic fibres because they are biodegradable and non-abrasive. The disposal of natural fibre composites is easy, they can be easily combusted or decomposed at the end of their product lifecycle. As compared to the cost benefits synthetic fibres, natural fibres comparably offer high security if used for automotive applications.

B. Characteristics of a banana fibre: The physical and chemical properties of banana fibre are considered below:

A. The chemical composition of banana fibre is cellulose (50-60%), hemicelluloses (2530%), pectin (3-5%), lignin (12-18%), water soluble materials (2-3%), fat and wax (3-5%) and ash (1-1.5%).
B. Its appearance is similar to that of bamboo and ramie fibre; however banana fibre has better fineness and spin ability.
C. It has shiny appearance depending upon the extraction and spinning process
D. It has very strong fibre with 3% elongation and light weight.
E. Its average fineness is 2386 Nm, average strength is 3.93 cN/dtex and average length is 50 ~ 60 mm (or 38mm).
F. It absorbs and releases moisture easily.

G. It can be spun by different methods like ring spinning, open-end spinning, best fibre spinning, and semi-worsted spinning.
H. It is bio-degradable and has no negative effect on environment and thus can be categorized as eco-friend fibre.

C. Mechanical Extraction of Banana Fibre:

- The manual (or) semi mechanical extraction of banana fibre was tedious, time consuming and causing damage to the fibre. So after intensive study and research a simple low cost user friendly CTRI Banana Fibre Extractor machine was designed and developed for extracting Banana fibre mechanically from banana pseudostems, leaf stalks and flower stalks.
- The method is simple and the machine is sufficient to extract fibre from Banana stems. It is very user friendly. Anyone can operate it with a training of just 30 minutes. This machine reduces the drudgery of manual extraction of fibre and provides a clean working environment. It will help the workers to produce more fibres and get increased income.

II. Literature review

[1] R. Bhoopathi, M. Ramesh, C. Deepa, this paper concluded that the present unsustainable environmental condition natural fibers are serving better material in terms of biodegradability, low cost, high strength and corrosion resistance when compared to conventional materials. The benefits of components and products designed and produced in hybrid composite materials instead of metals recognized by many industries. The main objective of this experimental study is to fabricate the banana-hemp-glass fibers reinforced hybrid composites and to evaluate the mechanical properties such as tensile strength, flexural strength and impact strength. There are three different types hybrid laminates are fabricated by hand lay-up method by using glass, banana and hemp fibers as reinforcing material with epoxy resin..

- The banana-glass fiber hybrid composites have more tensile strength than other composites can withstand the tensile strength of 39.5MPa followed by the hemp-glass fiber reinforced composites which holds the value of 37.5Mpa.
- The maximum flexural strength of 0.51kN hold by the banana-hemp-glass fiber reinforced composites followed by banana-glass fiber reinforced composites which is having the value of 0.50kN.
- The impact strength of the hybrid composites varies from the 5.33Joules to 8.66Joules.

[2] K. L. Pickering, M.G.Aruan Efendy and T. M. Le, this paper concluded that Much research and progress has occurred in recent decades in the mechanical performance of NFCs. Improvement has occurred due to improved fibre selection, extraction, treatment and interfacial engineering as well as composite processing. This paper has reviewed the research that has focussed on improving strength, stiffness and impact strength including the effect of moisture and weathering on these properties; long and short term performance was addressed. NFCs now compare favourably with GFRPs in terms of stiffness and cost; values of tensile and impact strength are approaching those for GFRFs. The lower densities for NFCs lead to better comparison for specific properties. Applications of NFCs have extended dramatically including load bearing and outdoor applications such as automotive exterior underfloor panelling, sports equipment and marine structures. Further research is still required to extend their application range including improvement of moisture resistance and fire retardance. Overall, growth of NFC uptake continues at a rapid rate and there would appear to be a very positive future ahead for their application.

[3] William Jordan, Patrick Chester, this paper concluded that the interfacial bonding between banana fibers and an LDPE matrix: peroxide treatment and permanganate treatment. The effects of the treatments on the tensile properties of individual banana pseudo-stem fibers were explored, with peroxide treatment enhancing the tensile properties and permanganate treatment having an inconclusive effect. Some interesting results from composite processing are briefly explored, leading to peroxide treated fibers being excluded from composite testing. The flexural and tensile properties of untreated and permanganate treated injection molded composite parts were then explored. Untreated banana pseudo-stem fibers provided a measurable increase in composite properties, especially in tensile stiffness. Banana pseudo-stem fibers provide a unique opportunity for reinforcement of thermoplastics such as LDPE. Peroxide and permanganate treatment serve to enhance the interfacial bonding of banana pseudo-stem fibers to their LDPE matrix. Peroxide treatment has the additional effect of enhancing the tensile properties of individual fibers, whereas permanganate treatment has an inconclusive effect on the tensile properties of individual fibers. In terms of composite flexural properties, untreated banana pseudo-stem fibers enhanced the strength and stiffness considerably, with an increasing effect with increasing fiber volume fraction. The permanganate treated composite behaved similarly to the untreated composite, with a slight enhancement in properties compared to the untreated composite at 10% fiber volume fraction and a slight reduction in properties compared to the untreated composite at 20% fiber volume fraction. This may be due to permanganate treated fibers breaking apart as they rub past each other during processing due to their roughened surface. In terms of

composite tensile properties, untreated banana pseudo-stem fibers slightly enhanced composite strength and greatly enhanced composite stiffness with an increasing effect with increasing fiber volume fraction. The permanganate treated composite behaved similarly to their untreated composite counterparts at equivalent fiber volume fractions, either matching or slightly underperforming the untreated properties. These trends for the permanganate treated composite do not match the trends shown in other literature, and it may be that in other literature the fibers were alkali pre-treated before the permanganate treatment. In conclusion, banana pseudo-stem fibers provide some measurable enhancement to LDPE properties, especially in terms of tensile stiffness. Permanganate treatment appeared to enhance the interfacial bonding but otherwise appeared to provide little to no advantage over the untreated composite in terms of tensile and flexural properties. This may be due to the permanganate treated fibers not being alkali pre-treated prior to permanganate treatment.

[4] Zaida Ortega, Moisés Morón , Mario D. Monzón , Pere Badalló and Rubén Paz, this paper concluded that Fibers have been extracted by mechanical means from banana tree pseudostems, as a strategy to valorize banana crops residues. To increase the mechanical properties of the composite, technical textiles can be used as reinforcement, instead of short fibers. To do so, fibers must be spun and woven. The aim of this paper is to show the viability of using banana fibers to obtain a yarn suitable to be woven, after an enzymatic treatment, which is more environmentally friendly. Extracted long fibers are cut to 50 mm length and then immersed into an enzymatic bath for their refining. Conditions of enzymatic treatment have been optimized to produce a textile grade of banana fibers, which have then been characterized. The optimum treating conditions were found with the use of Biopectinase K (100% related to fiber weight) at 45 C, pH 4.5 for 6 h, with bath renewal after three hours. The first spinning trials show that these fibers are suitable to be used for the production of yarns. The next step is the weaving process to obtain a technical fabric for composites production.

[5] Preethi P and Balakrishna Murthy G, this paper concluded that the world. Banana farming generates huge quantity of biomass all of which goes as waste and the above ground parts like pseudostem and peduncle are the major source of fibre. Banana fibre can be used as raw material for industry for production of range of products like paper, cardboards, tea bags, currency notes and reinforced as polymer composite in high quality The other non- cellulosic substances like hemicellulose, lignin and pectin were high in Monthan pseudostem fibre (15.75, 21.56 and 4.08%, respectively). Mechanical properties like tex and fibre diameter decides the fineness. Fine fibres were obtained from pseudostem of Nendran (24.23 tex and 0.119 mm, respectively). The breaking load, breaking extension and tenacity were found to be good in peduncle fibres of Nendran cultivar (332.33 g, 2.01% and 39.56 g/tex).dress materials. Fibre from pseudostem and peduncle of four commercial cultivars of Tamil Nadu viz., Grand Naine, Poovan, Monthan and Nendran were extracted using banana fibre extraction machine. The highest pseudostem and peduncle fibre recovery were obtained from Poovan (2.71% and 1.09%, respectively) and the lowest from Grand Naine (1.07% and 0.63%, respectively).

[6] Dr. M. Sukumar, this paper concluded that The principal aim of the present study is to develop a method for the production of cellulose nanofibers, from the banana peel (BP) and bract (BB). The microwave digestion method and ball milling assisted ultra-sonication method was optimized for sustainable extraction of micro and nano cellulose fibers, respectively. Micro and nano cellulose fibers of BP and BB were found to contain type I cellulose structure. Thermal stability and crystallinity index of cellulose nanofibers were examined to be higher than it's native micro cellulose. Nano cellulose fibers were examined to be a potential source for production of acetyl and lauroyl cellulose, with a high degree of substitution and thermal stability. Hence, microwave digestion and ball milling assisted ultra-sonication method was proven to be effective in the extraction of nano cellulose fiber for development of cellulose-based polymers.

III. Working and process

EXTRACTION OF BANANA FIBRE:

The processes for making yarn from banana fibres vary from region to region. Most popular methods among these are those followed in Japan and Nepal.

Japanese Method:

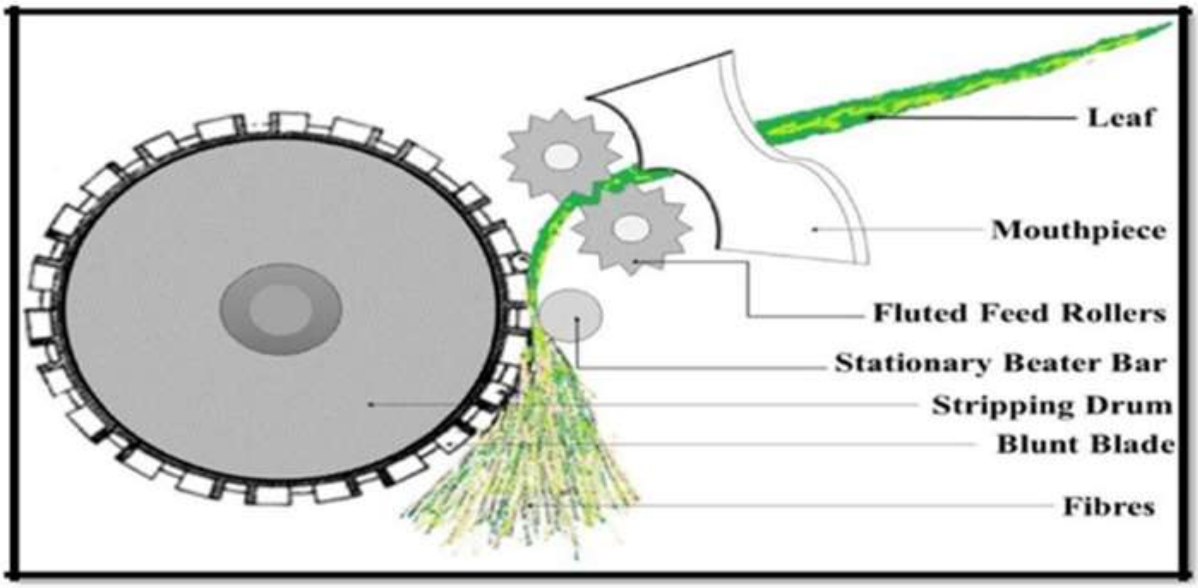
The cultivation of banana for clothing and other household use in Japan dates back to the 13th century. In the Japanese method of making banana fibre, the care is taken right from the stage of plant cultivation. The leaves and shoots of the banana plant are pruned periodically to ensure their softness. The harvested shoots are first boiled in lye to prepare the fibres for making the yarn. These banana shoots give away fibres having varying degrees of softness. This further results in yarns and textiles with differing qualities that can be used for specific purposes. The outermost fibres of the shoots are the coarsest ones. They are therefore, more suitable for making such home furnishings as tablecloths. The softest part is the innermost part that gives soft fibres which are widely used for making kimono and kamishimotraditional Japanese apparels. The banana cloth making process is a lengthy one and all the steps are performed by hand

Nepalese Method:

In Nepal, the trunk of the banana plant is harvested instead of the shoots. Small pieces of these trunks are put through a softening process for mechanical extraction of the fibres, and then bleaching, and drying. The fibre obtained thus has appearance similar to silk which has become popular as banana silk fibre yarn. This fibre is refined, processed and skeined mostly by the Nepalese women. Only the aged bark or the decaying outer layers of the banana plant are harvested and soaked in water to quicken the natural process. When all the chlorophyll is dissolved, only the cellulose fibres remain. They are extruded into pulp so that they may become suitable for spinning into yarn. The yarn is then hand- dyed. They have high textural quality similar to silk and as such employed in making high end rugs. These traditional rugs are woven by hand-knotted methods again by the women of Nepal

Fig. Scraping The Banana Pseudo Stem

WORKING PRINCIPLE:



The raw material i.e. plant stems/stalks/leaves are fed to the blade drum by the feeding device. The high-speed spinning blade drum and fixed blades break the raw material and separate the fibers and residue. Suitable settings are maintained in the machine to retain the essential properties of the extracted fibres.

IV. Conclusion

- This machine will reduce manual work and is suitable for mass production.

- The problem of impurities and knots can be solved with this kind of design. The factors affecting quality of fibre are Roller speed, feed of strips and speed of scrapper, the type of beater blades and the position of beating, the distance between the beating surface and beating blade defines quality.
- By choosing these factors, correctly quality and production of fibre can be increased.
- The distance between rollers plays an important role in fibre extraction. This kind of design provides fibre of good quality in terms of length.
- Less maintenance, easy to operate and easy to clean are some of the biggest advantages of the machine.

V. Scope and future work:

- It can be modified for other fibres such as bamboo.
- Microprocessor controllers can be used to vary the speed.
- Feed sensors can be used to vary the gap between feed rollers according to the fibre thickness.
- Positive drive systems may be anchored for all rollers.
- Pneumatic pressure systems can be adopted to ensure better control over pressure for quality fibre extraction.
- Dye uptake has to be extensively studied.
- The structure of fibres may be studied using FTIR and X-ray techniques.

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